

KNOWLEDGE PRACTICES LABORATORY (KP-LAB) OVERVIEW

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Introduction

Modern society is undergoing a profound transformation concerning the practices and tools for working with rapidly expanding body of scientific and professional knowledge. Professionals are required to manage complex knowledge through dynamically evolving forms of collaborative teamwork and sustained knowledge sharing. Innovation and knowledge creation activities are becoming commonplace and the most important sources of wealth. These changes call for new pedagogical approaches suitable to prepare students but also practitioners to actively participate in a knowledge-based innovation society. While traditionally higher education and workplace learning have been aimed at making learners acquainted with the state-of-art domain knowledge and practices, today they are asked in addition to make active use of and contribute to the building of new knowledge. Towards this end there is a need for new methods and tools to support both students as well as practitioners in sustained efforts of collaborative knowledge building.

KP-Lab is a five year research and development project financed by the EU 6th Framework Programme conducted by 22 partners from 14 countries of Europe. KP-Lab is a multidisciplinary R&D effort where researchers from three fields aim to create a learning system which facilitates innovative practices of sharing, creating and working with knowledge in education and workplaces. The researchers of pedagogy and psychology investigate and develop theories and models of knowledge practices. The technology experts investigate the technological solutions to support the practices. KP-Lab technology will emerge through iterative co-design process that integrates theoretical perspectives, research-based pedagogical ideas and technological development. A series of field trials will be organized in authentic environments provided by the educational institutions and enterprises participating in the project to investigate empirically the knowledge practices as well as to test and evaluate the models and tools developed within the project.

Triological approach to learning is an emerging paradigm researched and conceptualised in the KP-Lab project. It goes beyond the conventional acquisition ("monological", within mind) and participation ("dialogical", interactive) approaches by emphasizing the importance of processes where learners focus on collaborative, long-term efforts for developing authentic shared objects (Hakkarainen et al. 2006). The shared objects can be concrete or conceptual artefacts, such as concepts, plans, products, or social practices. Within the triological approach, also individually performed activities and social interaction serve the sustained processes of developing some concrete, shared objects collaboratively for some subsequent use. Furthermore, reflection in triological learning is directed towards the examination of artefacts, social practices, and processes (i.e. shared objects) that represent advancements in knowledge, rather than the improvement of personal understanding or social interaction as such (Lakkala 2007, Bauters & al., 2008).

The limitations of current learning environments require development of novel technical applications to support the building of complex knowledge through dynamically organised collaborative teamwork and sustained knowledge sharing. The conceptions of knowledge vary a great deal, some of them emphasize more the conceptual aspects of creating knowledge whereas others address innovations embedded in new practices and social structures (Hakkarainen et al. 2006). The triological approach is not a specific pedagogical model and it can be used across wide variety of domains and contexts. Thus the technical applications and tools must be on one hand

generic and on the other hand adaptable to meet the specific needs and objectives of each user group. The users must be able to adopt and use the tools flexibly according to the evolving practices they are involved with. Furthermore, the applications must be open to enable collaboration beyond boundaries and for sustained practices for long time, not just within a course or an organisation. In typical educational scenarios, students solve complex problems for real customers (i.e., enterprises, research communities or public organizations) or pursue reflective field training in professional communities.

High-level requirements for the trialogical learning technology

The general goals have been further elaborated into driving objectives and high-level requirements for the technology development within the *co-design process*, which goes beyond classical software processes by integrating theoretical, pedagogical and technical work and by allowing the heterogeneous nature of the corresponding life cycles and time scales. The co-design process is divided into phases that allow for multiple threads of activities to handle various cases and tools/services and allows incremental development of cases and tools/services. The multi-threaded development converges at milestones of the design and system integration phases.

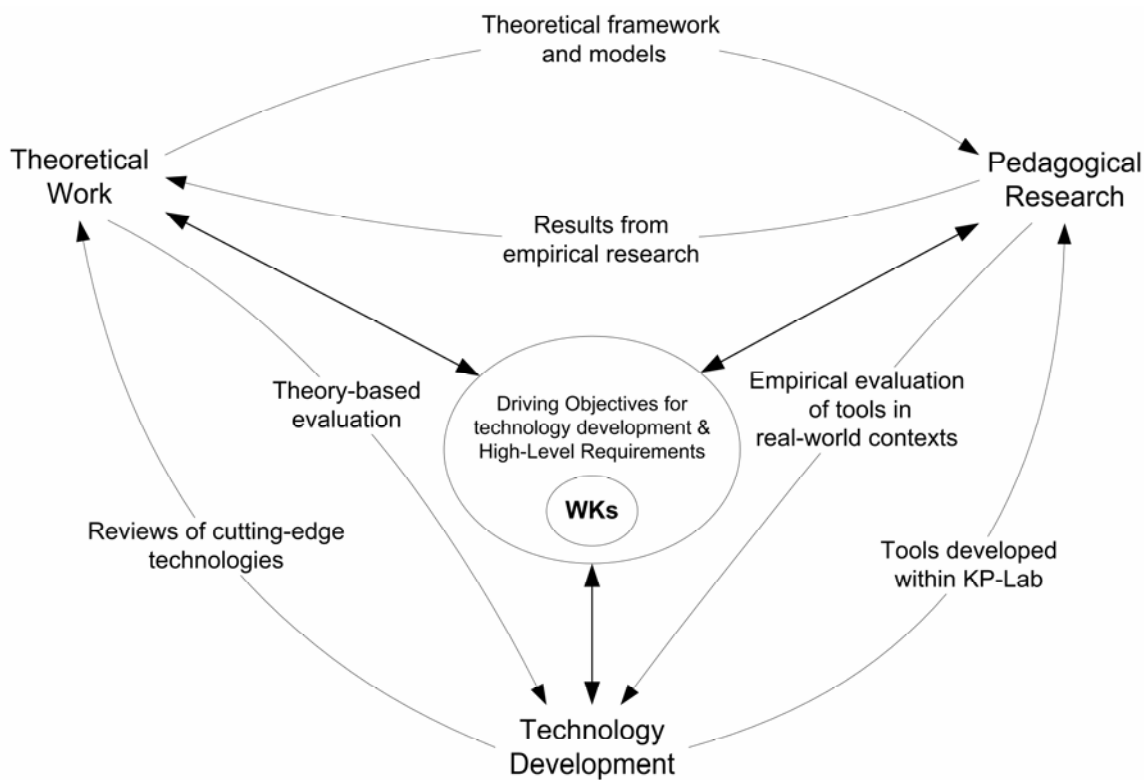


Figure 1. The co-design process for integrating theoretical, pedagogical and technical work.

The Driving Objectives for technology development provide overall scope and direction for the technology development. They reflect both the empirical results and theoretical foundations of KP-Lab and provide a means to cluster the respective high-level requirements (i.e. the overall functionalities and general properties KP-Lab tools shall provide to the user). The Driving Objectives do not, however, directly provide goals to all levels of technology development, but need to be further elaborated to user and functional requirements. Due to their pivotal role for the scope and organization of the co-design process and technology development, Table 1 outlines the Driving Objectives.

Table 1. The Driving Objectives for technology development.

User tasks	Driving objective for technology development
Organising shared objects and collaborative tools	DO1. Provide an <i>environment</i> where users can work on shared objects in one place.
	DO2. Provide flexible tools for working on shared objects.
	DO3. Support the collaborative development and re-use of shared objects and structures through iterative and incremental cycles.
	DO 4. Users can semantically and/or visually describe objects and their relations.
	DO 5. Enable users to contribute to shared-work in the shared environment (shared space application) from situated but distant places.
Modifying the content of the shared objects collaboratively (allowing also individual and personalised work)	DO 6. Provide users with possibilities to develop and integrate their own visual modeling languages, ontologies and vocabularies
	DO 7. Provide user with the possibility to create, use, and comment of various kinds of text-based documents collaboratively in sustained manner.
Management and Organisation of Collaborative Work Processes	DO 8. Enable users to plan and manage tasks of the knowledge creation processes.
	DO 9. Users are provided with history on content development and work process advancement
Creating contacts, communicating and networking	DO 10. Provide user with possibility to be in contact with people occupying different roles and share and comment objects across the fields
	DO 11. Provide user with networking possibilities with clients and other communities, maintaining sustained contacts with potential clients and community members
	DO 12. Provide users with virtual meeting facilities
Investigation and development of knowledge practices	DO 13. Provide users with means to capture, reflect, discuss and model their activity and to develop new models of working.
	DO 14: Provides users with an opportunity to conduct long-standing activity sampling studies in pedagogical settings and working environments

Interoperability requirements

Apart from the functional requirements, one key requirement for KP-Lab tools is the interoperability between and with 3rd party tools. Interoperability can refer to user-interface level, service-level or data-level collaboration. By user-interface level interoperability we mean that the

user-interfaces of two applications are integrated so that user-interface of one application can be invoked from the user-interface of the other. By service-level interoperability we mean that one application is able to call a service provided by another application. This is done to extend the functionality of the calling application. By data-level interoperability we mean that one application is able to use the data created or stored by another application. In many cases interoperability of two applications requires collaboration on more than one level. For example, smooth user-interface level interoperability might require also data-level interoperability.

Limitations of current learning technologies wrt trialogical requirements

The high-level requirements for trialogical learning applications are only partially met by existing software tools since the majority of learning technologies, such as virtual learning environments or learning management systems, in common use today is focused on the management and delivery of pre-fabricated learning resources. Learning environments support mainly one-way activities from teacher to learner and provide only limited support for knowledge building activities, such as tools for project management, sustained discourse and exchange of resources. For collaborative work users are provided typically only with a storage space where they can store documents. The documents managed by these tools remain isolated in the system, or even within the organizational structures reflected by the system, without support for explicating and describing relation between them and without support for sustained development (e.g. Wilson, et al. 2006). Furthermore, often these systems are closed and groups can only exist within one organization.

The development of learning environments that link together collective and community tools and services is still very much at the beginning stage. The integration of the current tools to meet the needs of the trialogical learning is difficult and requires the re-engineering of the software, which in turn makes maintenance of the system more difficult. Another problem is that the quality of the technical implementation of the software varies a lot and makes the re-use challenging. Currently not enough of attention is paid to the interfaces and interoperability of the tools and services.

Furthermore, the pedagogical foundation of most learning technology standards (e.g. learning objects, learning design) conflict the design principles of trialogical learning. The dominant benefits of standards reflect the desire to create new economic opportunities and are only distantly related to the human processes of learning and teaching (Marshall, 2004). Learning environments are often designed to replicate structures that reflect administrative rather than pedagogical needs. It can be even questioned if the current learning technology standards really support teachers and learners rather than constrain them.

Technology development

The technology research and development within the KP-Lab project aims at providing tools for collaborative knowledge building that support users in organising and managing the joint development of some concrete, shared knowledge objects for a meaningful purpose. The core tools allow users to create and modify shared objects (representing artefacts, activities/tasks, people), as well as organize them visually in different perspectives. For enabling the sustained collaborative work around shared objects, many other types of tools are developed as well, such as awareness, advanced search (relating searches to the content and context and arranging search results visually according to their semantics); semantic annotation of multimedia content, collaborative semantic modeling through visual models and visual modeling languages; meeting and conferencing support; discovery and exploitation of tacit and practice-related knowledge.

All KP-Lab tools share the core domain ontology, the Trialogical Learning Ontology (TLO). It defines the concepts and notions of trialogical learning domain that are needed in implementing tools' functionalities, interactions and data exchanges. TLO is extended by the tool ontologies in order to describe more specific semantics required. Integration with third-party applications poses additional requirements on the ontological modeling done in KP-Lab. As it is probable that third-party applications will not be using ontologies developed in KP-Lab project it is important to map KP-Lab ontologies to more generic ontologies and schemas such as Dublin Core to enable interoperability.

KP-Lab tools

Shared Space

The Shared Space is the core KP-Lab tool. It is a novel collaborative environment aimed to foster knowledge building and sustained work around shared objects. The environment builds on recent Web 2.0 and semantic web technologies and provides a set of generic tools for initiating and organizing collaborative processes, for creating, working on, sharing, and organizing objects collectively, for networking and community building, and for awareness and reflection on learning.

The core functionality of the KP-Lab Shared Space is the sharing and collaborative building of knowledge. Shared space provides users with flexible means to create and modify shared objects (representing artefacts, activities, people), as well as organize them visually in different perspectives. Artefacts can be files uploaded by user, web links, wiki pages, as well as text notes, and simple drawings directly created within the shared space. Besides a process-, content-, and community-oriented views, which are available by default, users can create customized views which allow focusing on a subset of resources available in a given shared space.

Users are able to provide, within the context of their activity, informal and semantic descriptions of shared objects and their relationships (links) by adding free-text comments and semantic tags to the objects and their relations. Users can also respond to previous comments, hence creating a resource-centered discussion thread. In addition to pre-defined semantic tags, users are able to adapt the system for their needs e.g. by importing, creating and modifying domain specific vocabularies used in semantic tagging. Advanced semi-automatic tagging features based on text mining are under development. Semantic descriptions will be used by the advanced contextual search tool that combines free-text and semantic search and can arrange the search results visually according to their semantics.

KP-Lab Shared Space includes two tools to support the management of processes and tasks. The Knowledge Process tool supports the planning and visualizing of knowledge processes (in terms of tasks, their relationships, resources, and responsibilities) within a shared space. It should be noted that trialogical learning processes are weakly structured and pre-defined sequencing of activities is not conceivable (other than on a very coarse level). The goal is not to formally describe a pedagogical design but to provide means for plan/design to evolve during the practice, such as course, using a visual language. The To-Do tool supports planning and managing of individual user's work. To-do is a list of tasks that have to be completed, such as steps toward completing a project or process. It interoperates with other KP-Lab tools, which can easily create new tasks in user's the to-do list.

Reflection on learning, which is directed towards the examination of artefacts, social practices, processes around the shared objects, is an important aspect of the learning practices in trialogical learning. Basic support reflection and analysis of activities is provided by the real-time and the history based awareness features. Real-time awareness provides synchronously information and notifications about users' status and activities within a shared space. History and participation awareness logs information about activities or changes in objects. Logs provide source data for identification of new knowledge that can be used for analysis and improvement of on-going activities as well as for adaptation of the graphical user interface or for personalization. In cooperation with services provided by the semantic web middleware, advanced awareness functionality will be provided to e.g. suggest related readings for users, to indicate what were the topics that has been talked about, where is the discussions actually going on, how they are interrelated, as well as a possibility to present graphical view (maps) that show how the participants are related to the shared artefacts as well as to each other. More advanced tools for analyzing and visualizing knowledge evolution will be implemented at the later stage of the project. They will support e.g. explorative analysis into the data to learn how people contribute to the community, what kind of groups are formed etc.

The KP-Lab middleware provides generic notification mechanisms that allow user (or tools) to subscribe for notifications about changes in knowledge stores in the knowledge repository. In addition, users can publish simple announcements of their intended (learning, work or social) activities to the colleagues and then see who else around would like to do the same.

Shared Space provides user community tools to support user managed networking and community building. These tools allow users to change their roles and have multiple roles in different contexts, to present, visualise and maintain their social networks and contacts, as well as to communicate with other users. The community tools will interface with external social network services allowing users to exchange information outside the KP-Lab environment. Common synchronous communication tools will be tailored for use in shared space, e.g. a context-based chat allows creating chat session for the current group/community the user is acting in, initiating a chat on an object among users that have interest in it, and saving chat history as an artefact in a Shared Space.

The Shared Space application is fundamentally ontology driven. Its functionality is based on the Shared Space application ontology and the Trialological Learning Ontology and it adapts to the application domain discourse by making use of domain ontologies. The KP-Lab Trialological Learning Ontology is the foundational data model providing common semantics for the applications and platform services. It is extended by the Share Space Application ontology that models the concepts used in the visualisation of the objects available in a shared space. The basic characteristics of the shared objects are described using the Dublin Core metadata standard. The objects can also be annotated with semantic concepts available in domain ontologies made available in a shared space. The relationships between the objects are defined in a link vocabulary that can be domain specific. The extensive and flexible ontological modeling of the shared learning space is used to provide advanced semantic search as well as knowledge visualization and analysis facilities.

Collaborative Semantic Modeling

In current professional and educational practices, the development and specification of visual modeling languages as well as ontologies is often carried out by dedicated “experts” and hence often detached from the work of those who use the actual modeling language or ontology. In many educational and professional settings users are usually trained to use one particular language to carry out a certain task. They usually don't have the possibility to choose among different languages or to adapt a language to their particular needs.

KP-Lab project is developing flexible tools for collaborative semantic (= ontology-based) modeling (CSM), to be used by learners and workers within the context of their learning and working activities. The term collaborative semantic modeling is used to refer those modeling activities that take into account the semantics of the modeling language used. This also includes the development and refinement of modeling languages (and hence their ontologies) itself. The CSM tools allow end users to develop visual models in the form of two-dimensional graph-structured representation of objects such as concept maps, flow-charts, argument-graphs, organigrams, decision trees, program logic models, use case diagrams, etc. In practice, collaborative modeling includes all those activities centered around the creation, modification, exchange, analysis, evaluation, revision, comparison and integration of models. There will be supported by two tools:

Semantic Multimedia Annotation

KP-Lab is developing a generic semantic multimedia annotation tool that will allow users to anchor annotations to video, audio and text content. Annotation can be one of three types: concept from existing domain ontology or from light-weight ontology (vocabulary or taxonomy) constructed while working with the content, written and spoken comment or link to external document.

Annotation is an activity that serves two objectives. First, to elucidate tacit knowledge embodied in the media. Second, to externalise one's tacit knowledge on the process or activity depicted by the media. Various annotation scenarios are possible:

1. individuals annotating video records of their own activity to allow them to become reflectively aware of their practices
2. individuals annotating others' activity to compare their own practices to those of peers or experts

3. learners annotating media featuring embedded knowledge to give a means to internalize (or make tacit) knowledge embedded in the media
4. experts analysing knowledge practices of community of practices to uncover knowledge practices prevailing in a community of practice.
5. groups reflecting on their own activity to become collectively aware of their habits.

Document Centered Collaboration

Several tools to support document centered collaboration will be available in a Shared Space, either tightly integrated or pluggable. Note Editor is a small text editor for direct creation and editing of notes within a Shared Space. It provides an easy to use tool to produce short notes, draft ideas as well as simple text documents. Drawing tool allows users to draw simple graphics for sketching and white-boarding purposes.

Shared Space also provides access to an integrated Semantic Wiki in order to support the group in producing more complex and structured text documents. The integration of a Semantic Wiki is needed in order to enable the users to easily open it from within a Shared Space and easily add the created wikipages as objects within the Shared Space. Navigating between a Shared Space and its corresponding Wiki is supported by making it possible to go from a wikipage and see it as a content item inside the shared space it is related to.

Change Laboratory

Change Laboratory is a method for exploring and initiating developing work practices by the practitioners together with the interventionist-researchers (Engeström et al., 1996). The central tool of traditional Change Laboratory is the 3x3 set of surfaces for representing the work activity. Project will develop a specific Virtual Whiteboard application that is based on the traditional physical whiteboard setting with extended features such as flexible editing and linking of concepts and presented digital material. Virtual Whiteboard will also support semantic annotation of presented material to enable a new dynamic way of representing the produced material and Change Laboratory concepts. It will allow flexible editing of material and notes can be made and edited during the discussions. Furthermore, already produced material is available for reediting or copying.

Another tool to support Change Laboratory process is the Analysis Toolkit, which will make use of the semantic multimedia annotation tool for analyzing video, audio, graphical and textual data using ontology of activity theoretical framework. It allows to perform preliminary analysis of activity by marking, classifying and linking relevant segments of data. Analysis supporting functions such as profiling of activities, predictive analysis of CL process, or glossaries of theoretical concepts will be implemented in the later phase of the project.

Meeting and Conferencing Support

The Meeting Support Tools support the definition, preparation, execution and reflection of collaborative knowledge advancements through meetings. Meetings outcomes can be saved as artefacts in Shared Space. The Map-It tool is a multi-platform rich-client tool allowing for asynchronous (preparation, reflection) and synchronous (discussion/argumentation/social interactions capture, collaborative reflection) work in meeting settings. M2T facilitates administration and preparation of meeting templates, direct synchronisation of Knowledge Objects from the Shared Space and GUI integration with other KP-Lab tools (Shared Space and Change Laboratory mainly). In addition, a multi-user Web conferencing end-user tool will be provided for the users. The aim is to be able to include the GUI component within Shared Space to configure and establish a conferencing session. The tool will be based on the multimedia conferencing platform that relies on the interactive video capabilities to stream live media to heterogeneous end-points.

Mobile Tools

Mobile access to Shared Space will be provided by a Mobile Memo tool. It will allow users to record text notes, pictures, audio, and video on the mobile device and save the files and their

metadata into a selected shared space as an artefact. It allows users also to retrieve to the mobile application artefacts from a shared space.

CASS tools have been developed to support the pedagogical research done in the KP-Lab project. CASS stands for Contextualized Activity Sampling System. KP-Lab has been developing the CASS methods for analyzing and modeling the epistemic and motivational mechanisms that exist in the background of students' knowledge creation activity in educational and workplace settings. The development of the CASS is motivated by new research paradigms for collecting data about respondent's experiences while they are engaged in activities taking place in natural environments.

The first tool is the CASS Query, which allows survey-type questions to be sent to a mobile telephone and answers returned to a database, where it can be transferred to statistics software used by researchers. CASS Query is a J2ME-application implemented on 3G mobile devices. The CASS Administrator tool enables researchers to manage CASS data collection by allowing to:

- construct queries, define questions and types of responses (open text, Likert-scale, audio- or video recording, image file).
- launch parallel studies, the data of which is accessible only to the defined researchers
- flexibly adjust desired sampling procedures in terms of different sampling strategies (even contingent, fixed interval and random sampling), timing as well as, creating and selecting various queries should be accessible to users
- select some of predefined automatic analyzing strategies supported by the system to provide feedback for the participants of ongoing follow-ups.
- customizing queries to each user

KP-Lab Architecture

Figure 2. provides a schematic view of KP-Lab systems identifying the end-users KP-Lab tools based on latest Rich Internet/Desktop Applications technologies, the KP-Lab platform and connection to external content management systems. Through its various components, the platform exposes a rich set of services based on SOAP, ReST or RSS (main examples) that can be used directly by KP-Lab tools, internally by other platform components but also by external (non-KP-Lab) systems and tools.

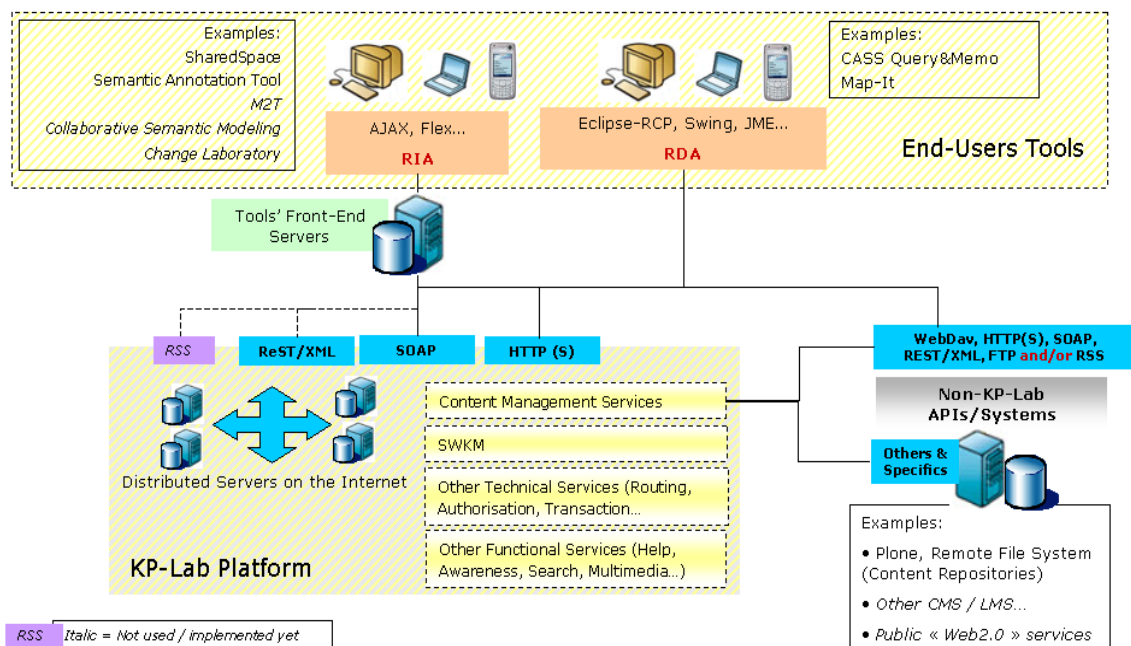


Figure 2 A schematic view of KP-Lab Platform interfaces

The KP-Lab tools are designed to integrate with the Shared Space, allowing users to plug them into as needed. Most of the KP-Lab end user tools are Rich Internet Applications (RIA), which are usually composed of a GUI part that will be implemented with Adobe Flex and a server side front end services. The server part provides the business logic services of the tool such as saving a new semantic tag to the knowledge repository. The Data Access Module provides tool GUIs the access to the server. The Synchronization Service is used to keep the cached graph model up-to-date and it is implemented using the Adobe Media Server. The Synchronization Service is used also to implement the real-time awareness features.

The KP-Lab platform leans on a flexible service oriented architecture that facilitates the integration and interoperability of KP-Lab tools as well as interactions with tier applications. The service and component interfaces build on common semantic data models that describe the semantics of knowledge objects being exchanged, with the Trialological Learning Ontology as a cornerstone.

The components of the platform expose services to the various end user tools with the objective of addressing similar needs in an optimized way. This includes pure technical facilities such as services registration, routing, transaction and synchronization mechanisms, gateways and libraries for content management, real-time conferencing and multimedia management platform, model-based transformations of data structures and software services that are more oriented towards shared functional needs (help material handling, multimedia management, search, participation and history-based awareness).

The KP-Lab platform provides following services “families”:

- *Repository Services* for Knowledge Management through a comprehensive set of semantic-based services provided by the SWKM
- *Content Management* services and gateways for dealing with external systems
- *Technical Services* (user management, authorization and authentication).
- *Multimedia & RT Communication*
- *Functional Needs-oriented Services* shared by one or several tools and necessitating server-side treatments (help material generation and treatment, search mechanisms, awareness, support for data mash-up / import / export mechanisms in tools).

The Semantic Web Knowledge Middleware (SWKM) is the part of the platform that specifically addresses the knowledge management services required by the trialological tools. SWKM aims to facilitate knowledge creation processes by supporting advanced interactions of collaborating learners (or workers) with knowledge artefacts (i.e. discovery, access, evolution, recommendation and mining). The proposed architecture broadly distinguishes three generic modules of the SWKM, i.e. the Knowledge Repository – responsible for the provision of scalable persistence services for large volumes of knowledge artefacts’ descriptions and ontologies; the Knowledge Mediator – responsible for the provision of services handling the main registry, discovery and evolution for KP-Lab knowledge artefacts; and the Knowledge Matchmaker – responsible for the provision of services that support interactions of KP-Lab users with knowledge artefacts employing their semantic descriptions.

The KP-Lab platform and tools will be mostly based on an open source so they will be widely available.

Conclusions and Future Work

The KP-Lab tools described in this paper are still work in progress and this paper only provides a snapshot of the achievements so far. In order to allow for extensive testing in real world contexts and to account for evolving users’ needs, the development of KP-Lab tools follow a cyclic approach,. Each cycle comprises the review of driving objectives for technology development, the elicitation of high-level requirements, design and revision of functionalities, technical implementation, as well as various stages of testing and evaluation. The technical development and field trials are continuing for next three years.

The feedback on first prototypes of the tools from students, teachers as well as practitioners indicated the potential added value of the tools. Especially their flexibility and genericity make them applicable to a broad range of pedagogical and professional scenarios. The second release of the tools has been made at the time of writing. It implements the extended and revised functionality based on the feedback from the first field trials.

Future design activities include, among others, extending the semantic capabilities of the tools, the integration of alternative models for process management, the configuration and tailoring of Shared Space towards specific scenarios, tools to support the re-use of knowledge objects and process structures build with the KP-Lab tools during earlier learning activities, improving the integration and interoperability of KP-Lab tools with 3rd party tools and services (e.g. office suites, learning management systems, Web platforms), and portability of content through functionality to import and export IMS L, as well as data export tools for research purposes.

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Curriculum Vitae

Hannu Markkanen: M.Sc. (Eng.) a Researching Lecturer in Media Engineering at Metropolia and will be Metropolia's project leader. He has been involved in and coordinated EU funded R&D projects in the field of learning technologies for past 15 years. His R&D experience includes knowledge-based expert systems, network-based learning environments and collaborative learning environments.

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Katriina Schrey-Niemenmaa: M.Sc (E.Eng) degree and MQ (Master of Quality) from Helsinki University of Technology. She has been in her current position as a project director at the EVTEK University of Applied Sciences since 2001. Prior to that she has worked for 20 years at the engineering education and industry - university co-operation interface focusing on competency management, life-long learning issues, quality in education and new learning solutions. This has included positions with Nokia, The Finnish Association of Graduate Engineers, TEK, and Kone Corporation.